Museum of Comparative Zoology
MAY 8 1940
LIBRARY

TRANSACTIONS
OF THE
SAN DIEGO SOCIETY OF NATURAL HISTORY
VOLUME IX, No. 19, pp. 163-194, plate 7, map

THE LYRE SNAKES (GENUS TRIMORPHODON) OF THE UNITED STATES

BY

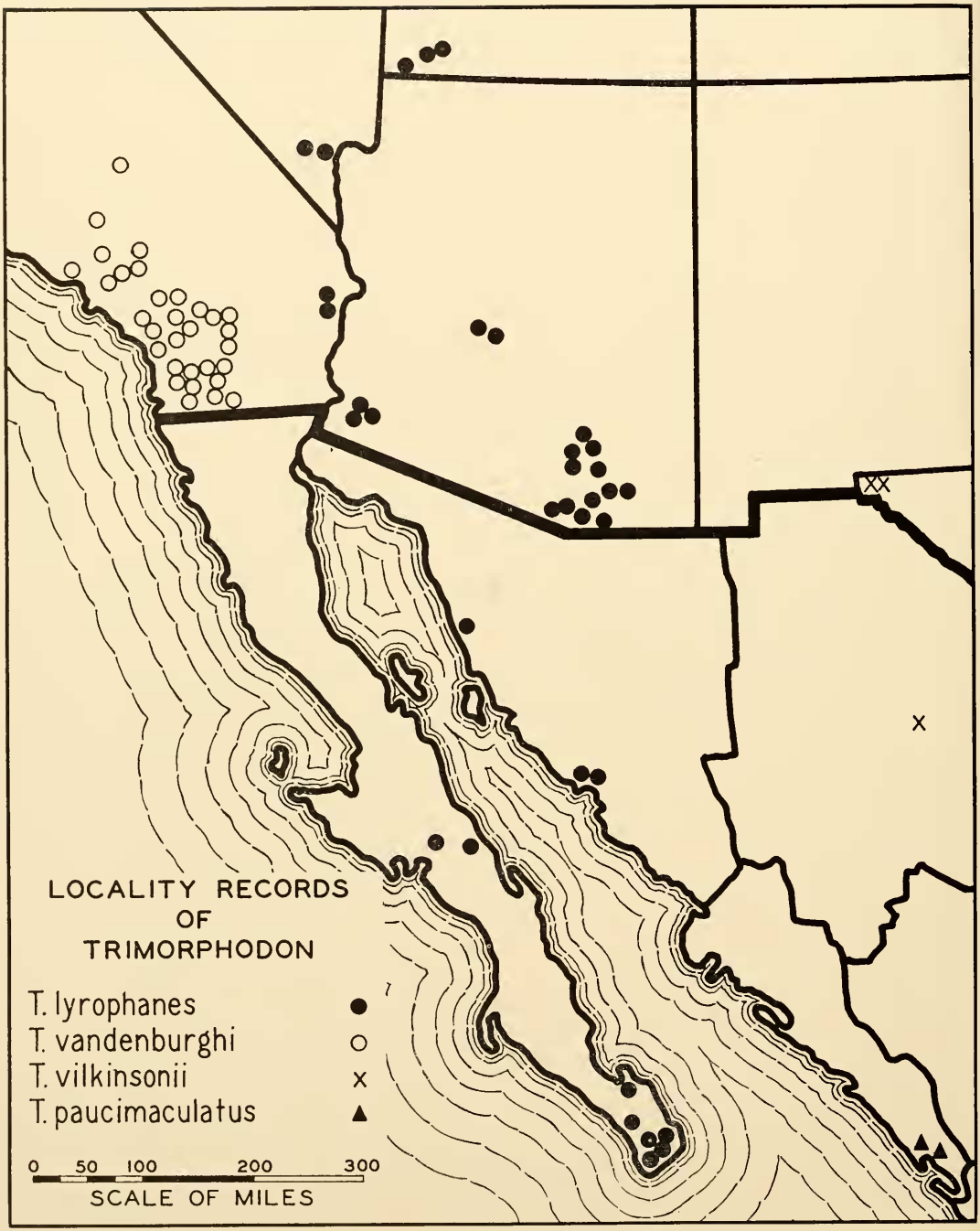
LAURENCE M. KLAUBER
Curator of Reptiles and Amphibians, San Diego Society of Natural History

TABLE OF CONTENTS

SAN DIEGO, CALIFORNIA
APRIL 30, 1940

2 8898

Zoology
MAY 8 1940
LIBRARY



28898

THE LYRE SNAKES (GENUS TRIMORPHODON) OF THE UNITED STATES

BY

LAURENCE M. KLAUBER

Curator of Reptiles and Amphibians, San Diego Society of Natural History

INTRODUCTION

The lyre snakes of the genus *Trimorphodon,* so named because of a lyre-shaped mark on the heads of most species, comprise a genus of back-fanged, nocturnal snakes occurring from the southwestern United States to Central America. While they are probably rather plentiful in some areas, they are infrequently captured, partly by reason of their nocturnal habits, and also because they are largely restricted to rocky areas, their customary day-time retreats being rock crevices. Thus, in the desert and semi-desert areas of the southwestern United States, their ranges comprise scattered rocky slopes and canyons, and they are absent from the greater expanses of the level plains.

These conditions restrict the number of specimens reaching collections, so that even now most of the species are only slightly known. In the last few years the writer has acquired some 45 additional specimens from the southwest, and others have been kindly loaned by various museums. There is now sufficient material available to determine character dispersions, and to permit solving some of the primary problems of relationship with respect to the species occurring in the United States and extreme northern Mexico. It is to these forms that the present paper is restricted. The best general summary of the genus, including the Mexican forms, which has appeared to date, is that of Taylor, 1939.

MATERIAL AVAILABLE

The sources of the specimens available for study are as follows:

Lower California	17
Southern California	55
Nevada	5
Utah	1
Arizona	14
Sonora	4
Texas	3
Total	99

TAXONOMIC SUMMARY

The species hitherto proposed, in the territory covered by this survey, are as follows:

Trimorphodon lyrophanes (Cope), 1860; type locality Cape St. (San) Lucas, Lower California.

Trimorphodon vilkinsonii Cope, 1885; type locality Chihuahua, Mexico.

Trimorphodon lambda Cope, 1885; type locality Guaymas, Sonora, Mexico.

Trimorphodon vandenburghi Klauber, 1924; type locality, Wildwood Ranch, San Diego County, California.

The problems which I have sought to solve are:

1. Should *vandenburghi* be reduced to a subspecific status?
2. Is *lambda* specifically different from *lyrophanes*, and to which of these species should the snakes of Arizona, southern Nevada, and southwestern Utah be referred?

The first question is the more easily answered: as far as presently available material indicates, full specific status should continue to be accorded *vandenburghi*. The condition of the anal plate is the best single character distinguishing this species, which inhabits the westerly fringe of southern California, from its congeners of the Cape Region of Lower California, Sonora, Arizona, southwestern Utah, southern Nevada, and extreme southeastern California. We have the following contingency table:

	Anal Entire	Anal Divided	Total
Non-*vandenburghi*	1	38	39
Vandenburghi	46	3	49
Total	47	41	88

It requires no calculation to demonstrate the significance of this unbalanced distribution. The only specimen of the non-*vandenburghi* series to have an entire anal is one of the cotypes of *lyrophanes* from Cape San Lucas. The three specimens of *vandenburghi* with divided anals are: LMK 27,136 from Sentenac Canyon, San Diego County; a specimen belonging to Harold Woodall from Silverado Canyon, Orange County; and MVZ 10,499 from near Palm Springs, Riverside County, California. There is no particular geographical consistency or significance in the sources of these three aberrants; many specimens with undivided anals have been taken around the same localities. Thus we have, in the anal plate, a rather stable difference by which all but about 5 per cent of the snakes can be correctly identified. It may be noted that this is a character usually invariant within a genus.

It is still not impossible that *vandenburghi* may intergrade with *lyrophanes*. Between the most northerly known Lower California specimens of *lyrophanes* (San Ignacio and Santa Rosalía) and the San Diego County border, the southernmost point where *vandenburghi* has been found (a distance of 400 miles), lyre snakes of some kind certainly occur, for this is the type of country in which they thrive. But whether *lyrophanes* and *vandenburghi* overlap or intergrade will not be known until specimens in adequate numbers become available from this intervening area. If there be intergradation, we may expect to find a locality in which specimens with anal plates divided and entire occur in approximately equal numbers. Or, if not in northern Lower California, possibly an intergrading series may be found between the Little San Bernardino Mountains in Riverside County and the west bank of the Colorado River, which is the western known limit of the Arizona colony of *lyrophanes;* or between the Death Valley region and the southern tip of Nevada. But here intergradation is somewhat less possible, since the mountains are isolated peaks scattered through the desert, and a continuous spread of population is hardly to be expected.

It should not be presumed that the condition of the anal plate is the only difference between *vandenburghi* and its congeners, for such is not the case; however, it is the simplest key character and is sufficient to demonstrate the presence of an essential difference. Other characters will be discussed under the species descriptions.

With respect to the second problem, namely, the relationship between *lyrophanes* and *lambda,* and the validity of the latter, I find the material still insufficient to permit a decision with any claim to finality. Tentatively, I conclude that *lambda* is not a valid species; additional specimens may warrant its retention as a subspecies of *lyrophanes,* but I do not so recognize it at this time.

We have only one territorially homogeneous series of *Trimorphodon* large enough to determine the dispersion of characters within a species; this is a series of 29 *vandenburghi* from coastal San Diego County. A study of this series discloses a rather high degree of variability in scale counts, color, and pattern. And not only do we find the usual and expected sexual dimorphism in ventrals and subcaudals, but likewise it is evident in scale rows, body blotches, and tail spots. Another complication in *Trimorphodon* is that the tail is very delicate and often incomplete, so that from many specimens no data on subcaudals and tail spots are obtainable.

In characters where sexual dimorphism is present it is a doubtful expedient to combine the sexes in differentiating species or subspecies, since, if the sexes be in different proportions in the two groups, what seems to be a subspecific difference may really be only the result of sexual dimorphism. So in the present study of *lyrophanes* and *lambda* we are under the necessity of dividing an already scanty material into two sex groups (in considering several important characters) with the result that, in a genus characterized by considerable variability even within a geographically homogeneous series, such differences as are found are doubtfully attributable to true subspecific divergence, for they may come about only through the chances of random sampling.

Cope, 1900, p. 1101, differentiates *lambda* from *lyrophanes* by the following characters:

Lambda	*Lyrophanes*
Brown chevrons on head	Lyre-shaped pattern on head
Brown collar on neck	Parallel stripes on neck
Diamond-shaped blotches	Dorsal spots in pairs

None of these characters is found to comprise a consistent difference between the specimens available from Cape San Lucas, Lower California, and those from the vicinity of Guaymas, Sonora, the respective type localities of these two forms It is true that in most of the former the two halves of the head chevron are separated by a narrow mid-dorsal light line, thus forming a lyre, while in the Sonora specimens the halves are joined; but the difference does not hold in all cases. As to the neck marks, they are quite variable, with both blotches and parallel marks noted in both series. With respect to the last of the three supposed differences—the blotch shape—this is only one of age. It happens that the type of *lambda* is a juvenile; and it is characteristic of the young of all our southwestern lyre snakes that the light cross-mark, which splits each dorsal blotch

transversely into the typical *Trimorphodon* double blotch, is faint, a juvenile condition by which Cope was misled.

Taylor, 1939, pp. 361 and 363, mentions differences in loreals, subcaudals, tail spots, and teeth. Since two out of the four specimens from Sonora (including the type) have three loreals, and the others two, this character does not represent a significant difference between the two groups, for Lower California specimens also have either two or three loreals. As to the two tail characters there is here an unquestioned average difference, of which the subcaudals seem the more impressive. The data from the available specimens are as follows:

SUBCAUDALS

	Males		Females	
Number	*L. Calif.*	*Sonora*	*L. Calif.*	*Sonora*
65			1	
66			1	
67				
68				
69			3	
70				
71	1			
72				
73				
74	1		1	
75	1			1
76	2			
77				
78				
79				
80				
81				
82		1		
83		1		
84				
85		1		

TAIL SPOTS

	Males		Females	
Number	*L. Calif.*	*Sonora*	*L. Calif.*	*Sonora*
11	2			
12				
13	2		2	
14				
15			1	
16	1	1	1	1
17		1		
18		1		

The differences in subcaudals are mathematically significant; yet in San Diego County, with larger series, the range of subcaudals within one sex is 12,

or almost as great as the maximum difference between the specimens from Lower California and Sonora. And the specimens from Arizona and Nevada are intermediate. So I think it best to consider *lambda* a synonym of *lyrophanes* until more specimens become available and the dispersion of these two characters within each subspecies can be better defined, or until other differences are discovered.

With respect to the teeth, studies must first be made of intrasubspecific variation to prove the validity of the differences stated to exist between *lyrophanes* and *lambda*. I lack the necessary skeletonized material and must leave this point undecided.

SPECIES DESCRIPTIONS

The following descriptions will summarize the data accumulated on the three species of *Trimorphodon* known to occur in the United States. *Vandenburghi* is treated first since our knowledge of this species is more extensive, and the discussion of the character variations will somewhat improve our understanding of the others.

Trimorphodon vandenburghi Klauber

CALIFORNIA LYRE SNAKE

Plate 7, fig. 1.

1924. *Trimorphodon vandenburghi* Klauber, Bull. Zool. Soc. San Diego, No. 1, p. 17. Type specimen: CAS 58,192. Type locality: Wildwood Ranch (elev. 1520 ft.), 5 mi. sw. of Ramona, San Diego County, California.

Diagnosis.—A species of *Trimorphodon* characterized by an entire anal plate, and a relatively high number of body blotches.

Range.—Coastal and desert southern California from Los Angeles County and the Argus Mountains, Inyo County, south to the Mexican border. Although not yet collected in northern Lower California, it unquestionably occurs there, for at several places it has been observed within a mile or so of the border. It prefers rocky habitats.

Material.—The following description is based on 52 specimens from southern California, of which 40 are from San Diego County. Both the coastal and desert sides of the mountains are represented.

Morphology.—The body is slender and racer-like, with a delicate, tapering tail. The head is very distinct from the slender neck, the temporal regions being especially enlarged; the relative proportions of head and neck differ from those of any other colubrid snake in this region. The snout is rounded and blunt. The eyes are notably protuberant, and are relatively large; the diameter of the orbit equals the distance from the eye to the nostril. The iris is flecked with gray and green in life; the pupil is vertical. The longest specimen taken to date measures 1055 mm. (41½ in.) over-all; it is a female. There are at hand five females exceeding 800 mm., but no males of this length; the largest male is 738 mm. It seems apparent that the females grow to a larger size than the males, as is the case with so many colubrids. The smallest specimen, one freshly

hatched, measures 205 mm.

The tail length in the males averages about 16.2 per cent of the body length over-all. The corresponding ratio amongst the females is 14.4 per cent. Most males will fall between 14.8 and 17.7, and most females between 13.2 and 15.5 per cent. Thus there is some overlap and it is not safe to sex specimens by the tail-length ratio alone. Because of the limited number of specimens available with complete tails, I am unable to determine accurately the ontogenetical tail length equation; there is no proof that the ratio changes with age, although such a change is evident and may be demonstrated in some colubrids.

The head length is about 3.2 per cent of the body length, over-all. The tongue is flesh colored, with a red line upon either side.

The extruded hemipenes are attenuated, unbifurcated, and with single sulcus. Proximally the shaft is smooth but with a twist, followed by a somewhat enlarged section covered with many tiny points. Distally it terminates in four transverse flounces separated by deep grooves; the outer edges of the flounces are serrated. As the flounces approach the sulcus they twist longitudinally and deteriorate into reticulated ruches. The end is rather broad and flat, with fringes forming a rosette. No spines are present.

The enlarged posterior canalized teeth are not prominent and are not easily located, except in the largest specimens. They will be found about even with the posterior edge of the eye.

Scutellation.—The body is covered with smooth and imbricate scales with rounded posterior ends. There are two apical scale pits, very small and faint, and observable on very few scales. There are from 21 to 24 scale rows at mid-body, the distribution among 48 specimens being 9–21, 12–22, 23–23, and 4–24. There are usually 22 or 23 rows at the neck, and 15 or 16 at the base of the tail. As is typical of *Trimorphodon* there is an unusually high proportion having an even number of rows, compared to other snakes. This results either from a splitting of the mid-dorsal to convert the normal 23 to 24, or the suppression of the mid-dorsal to make 22. Several changes in the rows may occur close to mid-body so that a number of counts may be necessary to locate the maximum. There is one pair of lateral suppressions, in which either the second and third rows above the ventrals combine to form a new second, or the third and fourth may merge into a new third. The other suppressions, required to reduce to 16 or 15 rows anterior to the anal, are all mid-dorsal; that is, either the odd mid-dorsal is suppressed, or, if there be an even number of rows, the two mid-dorsals are combined. There are normally five of these mid-dorsal reductions. This procedure is quite different from the regular dropping of lateral rows normal to most of the colubrids.

Sexual dimorphism in the dorsal scale counts of *T. vandenburghi* is evident as shown by the following data:

Rows	*Males*	*Females*
21	6	1
22	10	2
23	14	10
24	....	4

A chi-square test shows the difference to be significant (P equals 0.022).

The data on the ventrals are as follows: Males (29 specimens): maximum range 220 to 243,[1] interquartile range 226.8 to 233.7, mean 230.4∓0.95, coefficient of variation 2.23 per cent; females (18 specimens): maximum range 224 to 244, interquartile range 232.3 to 240.8, mean 236.56∓1.47, coefficient of variation 2.64 per cent. The anal is entire in 45 specimens out of 48.

The subcaudals are divided. The terminal cone is thin and delicate, and is frequently missing. In the males (27 specimens with complete tails) the subcaudals range from 66 to 80, interquartile range 68.1 to 72.5, mean 70.30∓0.62, coefficient of variation 4.56 per cent. The corresponding figures for the females (17 specimens) are: Extreme range 58 to 71; interquartile range 61.4 to 66.2, mean 63.76∓0.86, coefficient of variation 5.56 per cent.

The rostral is rounded, wider than high, recurved and deeply indented below. Only the point is visible from above; this separates the internasals for nearly one half of their depth. The internasals are relatively small, much smaller than the prefrontals; they are wider than high. The prefrontals are quite large, almost as high as wide, with a lateral extension curving down each side to contact the posterior loreals. The suture between the internasals is slightly diagonal, the anterior end being to the right, and the posterior to the left of the mid-dorsal line. The frontal is large, straight across anteriorly, and sharply tapering to a point posteriorly; it is longer than wide. The supraoculars are relatively small, shorter than the frontal; they do not extend out over the eyes. They widen somewhat posteriorly. The parietals are the largest of the head plates. Anteriorly they are partly separated by the point of the frontal; they narrow posteriorly. The upper postoculars partially separate the supraoculars and parietals. The nasal is divided at an angle into two equal parts, with the nostril at the upper end of the suture, which slants forward above. There are from 2 to 5 loreals; normally there are 3, a large anterior, a somewhat smaller posterior, and a much smaller subloreal below the posterior. Of the available specimens, 21 per cent have only two loreals; most of the rest have three, but four or five occur occasionally. Usually there are three preoculars, the upper being the largest, but eight per cent of the specimens have two preoculars, and one has only a single on one side. The point of the upper preocular contacts the frontal in a few specimens, but this is not normal for the species. Usually there are three postoculars, the lower being the largest; rarely specimens are found with two or four. In a few cases the upper postocular is the largest. The temporals are usually 2+3, or 3+4, but there are some specimens with 2+4, 4+4, or 3+5.

There are from 7 to 10 supralabials, the distribution being 1-7, 42-8, 40-9, and 3-10. The sixth and seventh are the largest; the fourth and fifth contact the eye.

---

[1] *Trimorphodon* is a genus in which it is quite difficult to determine the sex of all specimens with certainty. For this reason the extremes of some sexually dimorphic characters may be in error; the means and interquartile ranges are to be given greater weight than the extremes. The sign ∓ is used to indicate that the figure which follows is the standard, not the probable, error of the mean.

There are from 10 to 13 infralabials, the distribution being as follows: 4–10, 35–11, 37–12, and 7–13. The first pair meets on the mid-ventral line. The sixth and seventh are usually the largest; occasionally the fifth and sixth are largest. The first four or five contact the anterior genials. Rarely a cross-suture splits off a posterior tip of a first infralabial.

The mental is small and triangular. The genials are in two pairs; the posterior set is shorter and there is usually a small scale or two preventing the contact of the two members of this pair. There are 3 to 5 mid-ventral scales between the posterior tips of the pregenials and the first ventrals, and six to eight gulars between the last infralabials and the nearest ventrals.

Pattern and Color.—Although there is much variation in both head and body patterns, even in specimens from a single area, there seems to be a mode which many individuals approach. On the head there is a dark-brown transverse mark across the internasals, then a narrow light-gray transverse line across the front of the prefrontals, followed by a second, and wider, dark blotch across the posterior half of the prefrontals and the anterior edge of the frontal itself. Laterally this dark mark is carried backward and downward across the eyes on each side, until it terminates at the supralabials, anterior to the commissure. There follows a light line, rather narrow compared to the dark blotch which precedes it; this light line crosses the frontal at about its center, then passes backward and downward just behind the eyes, terminating at the commissure. The light line is again followed by a pair of wide dark marks—the lyre-shaped marks which give the snake its popular name. These arise on the posterior half of the frontal and diverge laterally as they pass backward across the parietals to the angle of the jaw. Sometimes the two components of the lyre marks join on the mid-dorsal line to form a chevron rather than a lyre; but more often they are separated by a narrow mid-dorsal light line. In the space at the back of the head between the two lyre marks there is a triangular dark blotch with the point directed forward. This leaves a wish-bone shaped light mark between the lyre blotches and the central dark triangle.

The upper labials are speckled with brown, especially between scales. The anterior infralabials are generally spotted. On the under surface of the lower jaw there are usually clumps of punctations at the posterior end of the first pair of infralabials, the ends of the pregenials, and on each side of the postgenials. In desert specimens, however, the upper labials are spotted between scales only and the lower jaw is usually immaculate.

Sometimes the dorsal-blotch series begins with a single dark blotch on the neck, sometimes with paravertebral bars. The dorsal pattern comprises a set of dark-brown hexagons, 4 to 6 scales (end to end) long and about 15 scale rows wide, upon a buff, or gray, ground color. Each blotch is split across the center by a narrow transverse light line from ½ to 2 scales wide. These light division marks end before they reach the lateral angles of the hexagons. The modal pattern is much easier to discern in the juveniles than in the adults, because the juvenile pattern is more regular, and there is a greater color contrast. The transverse splitting lines in the juveniles are narrower, darker, and, consequently, less conspicuous than in the adults. The interspaces between the

primary dorsal blotches are about 2 to 4 scales (end to end) long. Sometimes these light interspaces are darkened at the center by brown punctations, or even by brown transverse bands. Laterally there are secondary series, usually of twice the frequency of the dorsal blotches. Sometimes each alternate secondary forms an extension of the lateral angles of the primaries down to the edges of the ventrals. But often there is no agreement or spatial synchronism between primaries and secondaries. Sometimes there are about three times as many secondaries as primary blotches.

In the primaries the edges are darker than the centers. The interspaces are usually punctated with brown, more centrally than laterally; often there is a single light row around each primary.

The primary blotches vary from dark brown to light; and the interspaces from light brown to light gray. Coastal specimens are darker than those from the desert.

The ventral ground color is white, cream, or yellow, often with scattered brown dots; the edges of the ventral scutes are marked by the dark-brown blotches of the secondaries.

The tail spots are gradual degenerations from the split hexagons of the body to simple dark spots with lighter centers.

The following are some pattern notes on live specimens. The capitalized colors are those of Ridgway, 1912: In a specimen from Bear Valley near Escondido, San Diego County, California, the blotches were Rood's Brown and the ground color Vinaceous-Buff. In a light-colored desert specimen from the Little San Bernardino Mountains of Riverside County, California, the blotches were Buffy Brown to Wood Brown; the ground color varied from Tilleul Buff to Olive-Buff; and the ventral surface from Pale Olive-Buff to White.

Trimorphodon is often noticeably iridescent, more so than any other snake in this area.

Summarizing, the most characteristic items of the *T. vandenburghi* pattern, and, in fact, of several other species, are the lyre-shaped marks or chevrons on the head, and the light cross-marks splitting the body blotches.

In *vandenburghi* the body blotches vary from 28 to 43, interquartile range 32.6 to 37.3, mean 34.92 ∓ 0.49, coefficient of variation 10.02 per cent. The tail spots vary in number from 11 to 19, interquartile range 13.4 to 15.8, mean 14.62 ∓ 0.26, coefficient of variation 12.07 per cent.

Sexual dimorphism is evident in the *Trimorphodon* pattern. The males average 34.27 ∓ 0.59 body blotches and the females 36.78 ∓ 0.72. In tail spots the males average 14.54 ∓ 0.29, and the females 14.35 ∓ 0.41. The body blotches are significantly different in the sexes; but the tail spots are not.

Intraspecific Variations.—I have not available sufficient cismontane specimens from outside San Diego County to determine any north-south trends in scale counts and patterns. But there are significant differences between the specimens from the two sides of the mountains, that is, there are definite east-west trends.

The extent of the differences is shown in the following table of means:

Character	*Cismontane*	*Transmontane*	*Significance, P*
Scale Rows	22.68	22.33	0.27
Ventrals, males	228.36	233.29	0.065
Ventrals, females	235.67	243.67	0.052
Caudals, males	71.71	68.57	0.055
Caudals, females	63.91	64.33	0.87
Supralabials	8.72	8.35	0.016
Infralabials	11.71	11.30	0.041

The significances given in the final column were computed by the method of pooling and the *t*-test usually employed with small samples. The scale-row result is not to be considered significant, for it is above the usually accepted level of 0.05, namely one chance in 20 that the discrepancy noted is purely the result of the chance distribution of the available samples. With respect to the caudals one sex is not significant and the other in the opposite direction approaches significance. I consider the ventrals and labials most important. While the ventral result for each sex is slightly short of the usually accepted level of significance, they tend to reinforce each other. The labial differences are significant. I think we may safely conclude that desert specimens average higher in ventral scale counts and lower in number of labials than the cismontane snakes.

With respect to pattern, the same type of test discloses no significant difference in the number of body blotches or tail spots between coastal and desert specimens. However, in color there is a marked difference. Dorsally the coastal specimens are much darker and browner, for the desert specimens tend toward gray rather than brown, a condition observed both in the blotches themselves and the interspaces. The desert pattern is more strongly contrasting because of the relatively lighter ground color. Some specimens are quite light even to the blotches themselves; this is particularly true of those from the Little San Bernardino Mountains in Riverside County. In the desert specimens the upper labials are less spotted and the lower jaw is generally immaculate, whereas in the coastal specimens there are charactistic clumps of brown dots on labials and genials.

These differences are cited as a matter of general interest; I do not suggest that they are of sufficient magnitude to warrant recognition of the desert form as a separate subspecies.

Interspecific Relationships.—The similarities of *vandenburghi* and *lyrophanes*, and their geographic relationships are such that there can be little doubt but the former was derived from the latter. *Lyrophanes* inhabits a zone which completely separates *vandenburghi* from the main body of the *Trimorphodon* population in Mexico.

In color the cismontane *vandenburghi* are considerably darker and browner than *lyrophanes*, and they are characterized by brown spots on the labials and under-jaw not found in the latter species. But this is not true of the desert specimens of *vandenburghi*, which are lighter, grayer, and without gular marks; some, in fact, are lighter than any *lyrophanes*.

I have already pointed out that desert *vandenburghi* are higher in ventral scale counts and lower in labials than their coastal congeners. These trends do not continue into *lyrophanes,* for in these characters the desert specimens are not intermediate between the two, as might be expected from their territorial relationships. On the contrary, in both of these characters, *lyrophanes* more closely approaches coastal *vandenburghi* than the nearer desert specimens.

Grouping all available specimens of *vandenburghi* (36 coastal, 18 desert) and all 41 *lyrophanes* (17 Lower California, 1 California, 5 Nevada, 1 Utah, 13 Arizona, and 4 Sonora) we have the following table of means, with the respective significances of the differences ascertained by the *t*-test. I have not segregated the sexes in considering scale rows, although some sexual dimorphism is evident in this character.

Character	*Vandenburghi*	*Lyrophanes*	*Significance of Difference, P*
Scale rows	22.46	22.20	0.21
Ventrals, males	230.24	228.56	0.24
Ventrals, females	236.56	234.35	0.29
Caudals, males	70.30	78.71	0.00001—
Caudals, females	63.76	68.57	0.0014
Supralabials	8.52	8.91	0.00005
Infralabials	11.57	12.23	0.00001—
Body blotches, males	34.27	27.63	0.00001—
Body blotches, females	36.78	28.94	0.00001—
Tail spots, males	14.54	14.16	0.46
Tail spots, females	14.35	13.25	0.10

The characters which show a significant difference beyond the 0.05 level (i.e. less than one chance in 20 that the samples were drawn from the same population) are the caudals, labials, and body blotches. *Lyrophanes* averages higher in caudals and labials than *vandenburghi,* but is lower in body blotches; and the differences are in the range beyond $P=0.01$—that is, they are highly significant. Nevertheless, in no case is the difference such as to be unerring in a key, for there is considerable overlapping. Probably the best of these characters is body blotches; if we divide the males at 30 (*vandenburghi* 31 or more, *lyrophanes* 30 or less), and the females at 32 (*vandenburghi* 33 or more, *lyrophanes* 32 or less), fewer than 5 per cent of the specimens keyed by this character will be classified inaccurately. But the nature of the anal plate remains the best single key character as shown by the following table, which has been discussed before:

	Anal Entire	Anal Divided	Total
Vandenburghi	46	3	49
Lyrophanes	1	38	39
Total	47	41	88

Ecological and Field Notes.—Although *T. vandenburghi,* being nocturnal, and confined largely to boulder strewn hillsides, is not a common snake in collections, enough specimens have been observed to give us some knowledge of

its habits. I have also included here the few notes available on *T. lyrophanes*, on which little information is to be had; it is to be understood that the following remarks refer to *vandenburghi* unless otherwise specifically stated.

We know that *vandenburghi* prefers rocky habitats, although not entirely confined to them, and that it is most plentiful in the foothill areas on both slopes of the Peninsula Range in southern California. Even in the foothills it apparently prefers the lower levels; I have not collected it above 3000 feet on the coastal side, nor above 2800 feet on the desert slope of the mountains. No doubt these altitude records will be somewhat exceeded; but I question whether the snake will be discovered much higher in the mountains, since so many have been found below 3000 feet and none in the frequently hunted area above. Close to the coast it seems also to be very scarce; only a single specimen has been found within ten miles of the coast in San Diego County, and this at a point where some high hills abut the ocean.

In a record of snakes collected or observed during a sixteen year period in San Diego County (1923–1938) there were 44 *T. vandenburghi* out of a total of 12,947 snakes, or about ⅓ of one per cent. I think the true proportionate population probably greater than these figures would indicate, for its secretive and nocturnal habits militate against its capture, compared with many of the larger diurnal forms.

The zonal distribution has been as follows:

Coast	1
Inland valleys and mesas	11
Foothills	18
Mountains	0
Desert foothills	14
Desert	0
Total	44

We see from this table how closely these snakes adhere to two zones paralleling the ocean and mountains: a cismontane strip, comprising the higher mesas and lower foothills; and a desert-slope strip along the barren, rocky base of the desert mountains.

Specimens have been taken in every month except November; they were most plentiful in May and April, when 13 and 10 specimens, respectively, were found out of the total of 44.

Most of the specimens which have been taken alive have been found in one of two ways: either by prying off chunks from parent boulders, or by driving along paved roads at night. The first scheme is best for daylight collecting on the coastal slope, and the other for night collecting in the transmontane area.

In the first type of hunting it has been my experience that the lyre snakes do not take refuge under the thin rock flakes which so often harbor *Xantusia henshawi* and other lizards, and *Hypsiglena ochrorhynchus* amongst the snakes. Rather, they seem to prefer deeper and safer crevices, and thus more strenuous work is required to find them than by stripping off exfoliating sheets. Although some years ago I did extensive collecting of this kind, and must have pried off

a good many thousand flakes, I never found a *Trimorphodon* under one; but no less than five were found under chunks, although decidedly fewer of the latter were the subject of an investigating pinch bar.

In this manner the type specimen was collected on May 4, 1924. It was found under a large and thick fragment which was pulled away from a granite boulder. On May 1, 1926, at Viejas, one large and one medium specimen were found together in a crack between two boulders, from which they were extracted with difficulty. These snakes were discovered because a section of the body of one was visible from the surface. It was a cold, dark, and foggy day. On April 8, 1927, at Shady Dell, a specimen was disclosed under one large rock resting on another; and on April 20th of the same year at San Pasqual, one was discovered under a large cap rock, level and closely fitting to the top of a boulder. All of these points are in San Diego County.

Other collectors have had similar experiences. James Deuel found two young specimens under cap rocks a few hundred feet apart at the foot of El Capitan Mountain, on March 31, 1939. The San Diego Reptile Club collected three specimens in Moosa Canyon on its field trip April 24, 1938. Two were found in deep rock crevices as usual, but the other was lying coiled under a bush, near a pile of granite boulders, at 3:15 in the afternoon. It was a partly cloudy day.

Of the other type of collecting, that is by driving on desert roads and picking up the snakes found crossing the highway, as discussed elsewhere,[2] I have records of specimens collected at 7:25, 8:10, 9:00, 9:15, 9:55 P.M., and 12:30 A.M. On two of these occasions snakes were found abroad on unusually cold and windy nights. On the first evening, May 22, 1937, a lyre snake was crossing the road at 9:15 P.M. This was in upper Sentenac Canyon, air temperature 66° F., and a strong wind blowing. So adverse were conditions that night that, although this is in the best area for the night collecting of desert reptiles of which I have knowledge, not another snake was found in two hours and a half of travel. Again, May 6, 1939, on the aqueduct road along the base of the Little San Bernardino Mountains, Riverside County, near the Pushawalla branch, a specimen was crossing the road at 7:25 P.M., the temperature 64° and a gale blowing. Only three other snakes were found abroad that night, all sidewinders, two of them a mating pair. But the sidewinders were in a partially protected canyon, while the *Trimorphodon* was out in the open wash. These two experiences indicate that lyre snakes can probably withstand as unfavorable nocturnal weather conditions as any of our desert snakes.

The coastal-slope *vandenburghi* are so dark in color that they would be difficult to see in driving along a road at night, although finding specimens crushed by highway traffic shows that they do roam about at night. Charles E. Shaw found one crawling on the seat of summer house at Suncrest at 9:15 P.M., October 31, 1939. Some years ago C. Martinez wrote me concerning the capture of a *Trimorphodon* at Bear Valley, near Lake Wohlford: "On a dark night about 9:00 o'clock, my dog began to bark. I came out of the house and discovered the snake on a clear space close to rocky ground."

---

[2] Klauber, 1939.

Occasionally *T. vandenburghi* takes refuge under debris; one was found on the slope of Mt. Helix under an old horse-collar pad, lying with other debris near a burned house.

Few similar data are available on *T. lyrophanes*. Van Denburgh and Slevin, 1921, p. 70, mention one found in the thatched roof of a house at San José del Cabo, as it crawled over the rafters late in the afternoon. Dr. Berry Campbell found one trying to enter his tent at 11:30 P.M.; this was at Peña Blanca Spring, Arizona, Aug. 1, 1933. Dr. E. H. Taylor (1938a, p. 495) collected three near Guaymas, Sonora. One was crawling on gravelly ground at sea level about midnight, and another on similar terrain near the beach. The third was found tightly coiled in a niche in a low rock cliff near the sea at about 10:00 A.M. These specimens were referred by Taylor to the species *lambda*.

That *Trimorphodon* is a venomous snake has been amply proved, but it is probably not to be considered dangerous to man, because of its small size and the inefficiency of the biting mechanism, compared with that of front fanged snakes. *Trimorphodon* has several obvious handicaps: the fangs are relatively small; they are open channeled instead of closed tubes; and, most important of all, they are located so far back in the upper jaw that they can be effective only on objects of small diameter, and only then if conditions permit a sort of chewing of the venom into the wound. With such limitations the chance of being seriously bitten by a *Trimorphodon* is remote indeed; nevertheless it would be best to avoid undue carelessness with large specimens, particularly of the size reached by some of the species found in southern Mexico and Central America. The writer was once bitten by a *Trimorphodon,* but it was given no opportunity to chew, and there was no evidence of venom having gained access to the wound, nor did it differ in any other particular from that of a harmless snake.

An early observation on the effect of *Trimorphodon* venom was given by Dugès, 1884, (translation available in Stejneger, 1895, p. 348). He noted that the snake chewed its victim, a lizard of the genus *Cnemidophorus,* and at the end of a few moments the bitten animal died without convulsions.

On several occasions I have watched *Trimorphodon vandenburghi* eating lizards in captivity, usually *Xantusia henshawi*. In one such instance the snake grasped the lizard by the center of the body with the upper jaw so placed as to engage the lizard's ventral surface. The jaws were widely extended so that the posterior teeth were effective. The snake, without the use of its body for constriction or holding, bit repeatedly with spasmodic movements of jaws and neck muscles. The biting movements were at approximately four second intervals. This was kept up for seven minutes. Here I ceased observations, and, returning after ten minutes, found the snake engulfing the lizard head first. Upon being disturbed the lizard was dropped; it seemed lifeless except for a twitching of the tail. It was left in the cage and was eaten later. On another occasion the procedure was much the same; again the snake's head was turned so that the fangs engaged the under surface of the prey and the spasmodic biting was repeated. The lizard seemed quite dead in about ten minutes, after which swallowing began. Subsequent observations indicate that the engagement of the fangs in the less protected ventral surface of the lizard occurs so frequently that it must be deemed deliberate.

The most complete description of the fang of *Trimorphodon* is given by Cowles and Bogert, 1935. It is shown to be deeply grooved but with the canal unsealed in front. These investigators also carried on experiments with a specimen of *vandenburghi* about 700 mm. long to determine the effect of the venom on small mammals. A rat and a mouse were bitten. Both showed the effects of venom but recovered. The experimenters conclude that the venom is chiefly hemorrhagic in effect, and that while a painful wound might be produced in man, if the snake were allowed to chew, it would not be serious.

Rodman, 1939, reports that a specimen of *T. vandenburghi* in captivity bit a mouse in the tail and the venom seemed to affect the mouse severely. However, the snake killed the mouse by constriction. Later the *Trimorphodon* seems to have killed a small gopher snake by the use of venom, although it was itself killed by the constriction of the gopher snake.

To determine the approximate size and position of the fangs of *vandenburghi* I investigated my largest specimen, which has a body length over-all of 1055 mm. and a head length of 32.7 mm. The fangs were found to be opposite the rear of the eye, just forward of the suture between the fifth and sixth supralabials. This was about 13 mm. behind the rostral, and 12 mm. anterior to the angle of the mouth. The fangs have an F-length[3] of about 2.2 mm. They point backward at a decided angle, probably more than 45 degress from the vertical. They also turn inward somewhat and are slightly curved.

Captive specimens eat lizards readily; these are no doubt their principal food in the wild. Specimens of *vandenburghi* have been collected which had eaten *Xantusia henshawi* and *Uta stansburiana hesperis*. One *T. lyrophanes* had eaten a juvenile *Ctenosaura hemilopha*. But occasionally both *vandenburghi* and *lyrophanes* are found to contain mammal hair; one of the latter had caught a mouse. Probably *Xantusia henshawi*, the granite night lizard, comprises the principal food supply of *vandenburghi* in most areas, since they inhabit the same rocks and have much the same hours of activity.

In captivity *vandenburghi* has been fed *Xantusia henshawi, X. vigilis,* and small specimens of *Sceloporus*. I had a specimen which ate seven *X. henshawi* in three weeks. They normally take food only in the dark, are easily disturbed by light and drop the prey. However, this may sometimes be to secure a better hold for swallowing. Cowles and Bogert observed that one snake dropped the lizard it was attacking (*Xantusia vigilis*) about five minutes after striking it. The lizard was then dead and was dropped in order that a head-hold could be secured preparatory to swallowing. Rodman noted that a specimen constricted a mouse. I have not seen this done on lizards, for, with these, the snakes appear to depend on the effectiveness of the venom. One captive *lyrophanes* from Cape San Lucas ate a California linnet.

In captivity, *T. vandenburghi* shows itself to be a rather nervous snake. When annoyed it rears into a striking position with the anterior part of its body raised and the neck in an S-loop. The tail is vibrated rapidly. It will strike at

[3] Occ. Papers S. D. Soc. Nat. Hist., No. 5, p. 20, 1939.

moving objects with fair accuracy in the dark, but with poor direction in the light. It tries to retreat from danger by raising the anterior part of the body and always seeks refuge by going upward if it can. But this is not its normal crawling position when found on the road at night, for it progresses with head down in the usual way. When in captivity, if a bush be available it will spend much time in the branches. Possibly some of the Mexican and Central American forms may be partly arboreal.

Rodman, 1939, observed that a specimen dug in earth like other burrowing snakes, that is by advancing the head and neck into the soil and then withdrawing with the earth to be removed in a loop or crook of the neck.

Little is known concerning the enemies of *Trimorphodon*. In captivity one was eaten by a king snake (*Lampropeltis getulus californiae*). Several were observed to be infested by mites.

On May 11, 1933, a specimen of *T. lyrophanes* from Cape San Lucas laid 13 eggs. They averaged 30 x 17 mm. in size. Dr. R. B. Cowles has advised me that a large *vandenburghi* (length 1055 mm.) deposited 12 eggs in September. This was a desert specimen from the Little San Bernardino Mountains; it had been in captivity since May. Cowles and Bogert, 1935, have mentioned a brood of *vandenburghi* found in the wild just after birth. This was on October 1, 1934.

Locality Records.—California: *San Diego County* (*Cismontane*)—Agra (near San Onofre), Bear Valley (near Lake Wohlford), Richland, Moosa Canyon, Escondido (also 3 mi. w.), San Pasqual, Wildwood (type locality), Shady Dell, Mussey Grade, Padre Barona, 3 mi. w. of El Capitan, Foster (also 3 mi. e.), Lakeview (also known as Glenview or Johnstown), Flinn Spring, Chocolate Creek, Alpine, Viejas, Suncrest, Grossmont, Mt. Helix, Hillsdale, Deerhorn Flat, Dulzura, Cottonwood.

San Diego County (*Transmontane*)—San Felipe Valley, Sentenac Canyon, Yaqui Well, The Narrows, Carrizo, Jacumba (also 2 mi. w.), Mountain Spring Grade (near Imperial County line).

Imperial County—Mountain Spring, Myers Creek Bridge, Travertine Rock (U. S. 99 at Riverside County line).

Orange County—Silverado Canyon (Santa Ana Mountains), Black Star Canyon (Santa Ana Mountains).

Riverside County—5½ mi. sw. of Sage, Temecula, Perris, Mockingbird Canyon (s. of Arlington), Box Spring Grade (5 mi. se. of Riverside), Morena Grade (10 mi. w. of Beaumont), Tahquitz Creek (near Palm Springs), Pushawalla Canyon (Little San Bernardino Mountains), Berdoo Canyon (Little San Bernardino Mountains).

Los Angeles County—Mulholland Highway (Santa Monica Mountains), Sierra Madre, San Gabriel Canyon (near Azusa), Claremont, 4 mi. nw. of Acton.

San Bernardino County—Deadman's Point (Lucerne Valley).

Kern County—Red Rock Canyon.

Inyo County—Near Water Canyon (Argus Mountains).

Trimorphodon lyrophanes (Cope)

SONORAN LYRE SNAKE

Plate 7, fig. 2.

1860. *Lycodon lyrophanes* Cope, Proc. Acad. Nat. Sci. Phila., Vol. 12, p. 343. Cotype specimens (2): USNM 4680. Type locality Cape St. (San) Lucas, Baja California, Mexico.

1861. *Trimorphodon lyrophanes* Cope, Proc. Acad. Nat. Sci. Phila., Vol. 13, p. 297.

1886. *Trimorphodon lambda* Cope, Proc. Am. Philos. Soc., Vol 23, p. 286. Type specimen: USNM 13,487. Type locality: Guaymas, Sonora, Mexico.

1895. *Trimorphodon biscutatus* (part) Günther, Biologia Centrali-Americana, Rept. Batr., p. 174.

Diagnosis.—A species of *Trimorphodon* of moderate size, characterized by large body blotches, split transversely by light bars, and from 222 to 243 ventral plates. It differs from *vandenburghi* in having a divided anal plate, fewer body blotches, and a proportionately longer tail. It has more and longer blotches than *vilkinsonii.*

Range.—Southern and central Lower California, Sonora, southern, west-central, and northwestern Arizona, southwestern Utah, southern Nevada, and southeastern California bordering the Colorado River.

Material.—The description which follows is based on 41 specimens, of which 17 are from Lower California, 13 from Arizona, 5 from Nevada, 4 from Sonora, and one each from Utah and California.

Morphology.—The body is slim and attenuated, with a delicate tail. The neck is thin, and from it the head is very distinct, with the temporal regions particularly swollen. The snout is blunt and rounded. The eyes are peculiarly protuberant; they are large, with a diameter equal to the distance from the anterior edge of the eye to the rear of the postnasal. The iris in life is flecked with gray and brown. The pupil is vertical and is closed to the merest slit, even in subdued (north) light. The eyes are rotatable through a considerable angle and seem to have some independence of action.

The longest specimen available to date measures 1026 mm. (40½ in.); it is from Tucson, Arizona. The largest Lower California specimen is 1002 mm. long. Both are females. Out of 37 measurable specimens, four, including the two above, exceed 900 mm. Of these, three are females. The longest male is 912 mm. I think that *lyrophanes* is a somewhat larger snake, on the average, than *vandenburghi,* although I have one of the latter slightly larger than any available *lyrophanes,* and Dr. R. B. Cowles has told me of another of equal size (1055 mm., or 41½ in.). The smallest *lyrophanes* found to date measures 274 mm. The head length in adults is about 3.1 per cent of the length over-all. The tongue is pink.

The tail length in the males averages about 17.7 per cent of the body length over-all; the corresponding female ratio is 15.3 per cent. The majority of the

males will fall between 16.0 and 19.0, and the females between 14.0 and 16.5 per cent. *Lyrophanes* has, proportionately, a somewhat longer tail than *vandenburghi*. The limited number of specimens at hand does not permit a satisfactory determination of the ontogenetical tail-length trend; I therefore give the ratios as if there were no change with age, although such a conclusion is by no means assured.

The most accurate description of the dentition is that of Taylor, 1939, p. 361. This is from a skeletonized specimen taken near Guaymas, Sonora, Mexico. Taylor gives this under the species *T. lambda* and it is only referable to *lyrophanes* if I am correct in considering the former a synonym of the latter. The dental characters as given by Taylor follow: "Four anterior maxillary teeth enlarged, strongly curved, the first more slender and shorter than the others, the third largest of all the teeth; the middle part of the maxillary occupied by five teeth scarcely half the length and thickness of the preceding teeth; this group followed by one (two on right side) large, grooved fang, slightly curved, directed somewhat backward; seven palatine teeth, the anterior three or four considerably larger than the others; about 15 equal pterygoid teeth; about 17 or 18 mandibular teeth, the anterior two or three enlarged."

Since I have available no fully everted hemipenes from *lyrophanes* I can give only a tentative description. The organs are unbifurcated and with sulcus single. At the base the shaft is smooth, followed by an enlarged section covered with almost microscopic points. The outer end is decorated with flounces, but whether these are transverse or longitudinal, I have been unable to determine. Several spines seem to be present distally in one specimen.

Scutellation.—The body is covered with smooth and imbricate scales. Paired apical scale pits are faintly evident on a few scales. There are from 21 to 24 scale rows at mid-body, the dispersion among 40 specimens being 9–21, 14–22, 14–23, and 3–24. Thus, as is typical of *Trimorphodon,* there is an unusually large number of specimens having an even number of scale rows, as compared with most colubrid snakes, which seldom have an even number of rows. This results either from a splitting of the mid-dorsal row to convert the normal 23 to 24, or the suppression of the mid-dorsal to 22. In fact, dorsal, rather than the usual lateral condensations, are evident in *Trimorphodon.* Typical specimens with 23 rows at mid-body, have 22 rows on the neck and 15 or 16 just anterior to the anus. The anterior change is effected by a single mid-dorsal suppression; the posterior by one pair of lateral reductions (in which the third and fourth rows merge to form a new third) and 5 or 6 dorsal suppressions, scattered from the middle of the body to the beginning of the tail. In these, either the odd mid-dorsal is suppressed, or (if there be an even number of rows in this particular section) the two mid-dorsals are combined.

The data on the ventrals are as follows: Males (18 specimens): maximum range 222 to 235, interquartile range 225.8 to 231.3, mean 228.56 ∓ 0.97, coefficient of variation 1.80 per cent; females (17 specimens): maximum range 222 to 243; interquartile range 230.3 to 238.5, mean 234.35 ∓ 1.48, coefficient of variation 2.60 per cent. The anal is divided in 38 out of 39 specimens.

The subcaudals are divided. The terminal cone is thin and delicate, and

is often broken off and lost. In the males (17 specimens with complete tails) the subcaudals range from 71 to 86, interquartile range 75.8 to 81.6, mean 78.71∓1.03, coefficient of variation 5.39 per cent. The females (14 specimens) have the following variations: extreme range 63 to 76, interquartile range 65.9 to 71.3, mean 68.57∓1.07, coefficient of variation 5.83 per cent.

The rostral is rounded, wider than high, deeply recurved and indented below. The upper end is pointed and partially separates the internasals. The internasals are somewhat wider than high; they are much smaller than the prefrontals. The anterior loreals deeply indent the lateral sutures between internasals and prefrontals. The prefrontals are relatively large; they are sometimes wider than high, sometimes the reverse. The suture between them is slightly diagonal. The frontal is pentagonal or wedge shaped. The front is straight; the posterior point partly separates the parietals. The supraoculars are nonimbricate, shorter than the frontal, and widen posteriorly. The parietals are the largest of the head plates; they are narrower posteriorly. The nasal is divided at an angle; the nostril is near the top of the suture, which slants forward above. Of the available specimens, about one third have two loreals, and nearly all of the rest three; four or five loreals occur rarely. Where there are two loreals the anterior is the larger; it is quite high and a point at the upper end protrudes into the suture between the internasals and prefrontals. The third loreal, if present, is usually a small subloreal beneath the posterior of the first pair. Occasionally the posterior is split horizontally to form a fourth. Usually there are three preoculars, the upper being the largest. Ten per cent of the specimens have only two preoculars, and four have been found in two specimens. Rarely the point of the upper preocular contacts the frontal, but this is not normal in this species. There are usually three postoculars, the lower being the largest; some specimens are found with two or four. In rare instances the upper postocular is as large as the lower. The temporals are quite variable; they may be 2+3, 3+3, 2+4, or 3+4. A few specimens have been found with 2+2, 3+5, 4+4, and 4+5.

There are from 8 to 10 supralabials, the dispersion being 19–8, 46–9, and 12–10. The fifth and sixth, or, less often, the sixth and seventh are the largest; the fourth and fifth contact the eye.

There are from 10 to 14 infralabials, the distribution being 3–10, 15–11, 17–12, 28–13, and 4–14. The first pair meets on the mid-ventral line. The sixth and seventh, or the fifth and sixth are largest. The first four or five contact the anterior genials.

The mental is small and triangular. The genials are in two pairs; the posterior set is shorter than the anterior; usually there is a small scale or two separating the two members of the second pair. There are 3 to 5 mid-ventral scales (end to end) between the posterior tips of the pregenials and the first ventrals. There are usually seven or eight gulars between the last infralabials and the nearest ventrals.

Pattern and Color.—There is much variation in the pattern and color in this species. Essentially the body pattern includes a series of brown or gray-brown

dorsal blotches on a grayish background, each blotch being split by a transverse light bar.

On the head there is sometimes a brown transverse mark across the internasals, followed by a narrow light-gray transverse line across the front of the prefrontals, or this area may be gray or mottled. There is a dark band across the posterior half of the prefrontals and the anterior edge of the frontal itself. Laterally this dark mark is carried backward and downward across the eyes on each side, terminating at the supralabials, anterior to the commissure. This is followed posteriorly by a light bar, rather narrow compared to the dark blotch which precedes it; this light line (often punctated with dark brown) crosses the anterior half of the frontal, then passes backward and downward behind the eyes, terminating at the angle of the mouth. The light line is in turn followed by a pair of wide dark marks, the lyre-shaped marks from which the snake is named. These arise on the posterior half of the frontal and diverge laterally as they pass backward across the parietals to the angle of the jaw. Often the two marks representing the lyre frame join on the mid-dorsal line to form a chevron; sometimes, particularly in specimens from Lower California, this connection is prevented by the interposition of a narrow mid-dorsal light streak. (In Nevada specimens, instead of there being a single central light line between the two halves of the lyre, there are two lateral diagonal interruptions). In the space at the back of the head between the two lyre marks, or within the angle of the chevron, there is a triangular dark blotch with the point directed forward; this may, or may not, be joined to the first dorsal blotch on the neck.

The upper labials are usually light except for a few brown spots concentrated in the sutures. The lower labials and gulars are unmarked.

The primitive dorsal pattern, as seen in juveniles from Sonora and Nevada, comprises a series of dark-brown diamonds (with acute lateral angles) on a light-gray background. Each diamond is split transversely by a light-brown line. On the lower lateral scales there is a secondary series of small irregular dark marks of two to three times the frequency of the primary diamonds. These secondaries engage the outer tips of the ventrals.

As the snakes age, the color contrast between the blotches and the ground color becomes less accentuated. The lateral areas become filled with dark punctations, which are much more noticeable in *lyrophanes* than in *vandenburghi*. Usually the scale row contiguous to the blotches is less punctated than the other areas, so that the blotches seem bordered by light scales. The blotches are often darkest on their outer edges, particularly along the mid-dorsal line.

There is much irregularity in the size and separation of the dorsal blotches in the adults. Generally they are about 5 to 9 scales (end to end) long and about 14 to 17 scale rows wide. Each blotch is split across the center by a narrow transverse light line from ½ to 2 scales wide. These light division marks usually terminate before they reach the lateral angles of the main blotches. The interspaces between the blotches are about 3 to 5 scales (end to end) long. The blotches in the adults are quite irregular in shape, but are often hexagons or rectangles with pointed side extensions.

In the adults the primary blotches vary in color from dark brown to gray;

and the interspaces (behind the punctations) from buff to light gray.

The ventral ground color is cream, yellow, or tan, often with scattered brown spots; the edges of the ventral scutes are marked by the dark-brown blotches of the secondaries.

The tail spots gradually degenerate, from the split blotches characteristic of the body, to small dark spots with light centers.

The body blotches in *lyrophanes* vary from 21 to 34, interquartile range 25.9 to 30.2, mean 28.08∓0.52, coefficient of variation 11.30 per cent. The tail spots vary in number from 10 to 18, interquartile range 12.5 to 15.1, mean 13.77∓0.35, coefficient of variation 14.26 per cent.

Intraspecific Variations and Interspecific Relationships.—I have already discussed the relationship between *lyrophanes* and *vandenburghi* under the latter species, wherein it was indicated that the California form is probably an offshoot of the more widespread *lyrophanes*. *Lyrophanes* in its turn seems to be related to *biscutatus*, a larger Mexican species, or, more probably, to *paucimaculatus*. It differs so widely from *wilkinsonii* in pattern that a close relationship between the two appears doubtful.

I have examined two specimens of *paucimaculatus* from Mazatlán (Stanford 4087–8). I find these substantially in agreement with the description of the type (Taylor, 1937b, p. 527). The body and tail blotches (25–13, 24–12) are within the range of *lyrophanes;* the essential divergence from *lyrophanes* lies in the ventrals (251, 253), which are definitely higher than in that species. The pattern is not greatly different from some *lyrophanes,* and I should judge that a subspecific relationship between the two is by no means impossible. The Stanford specimens are like the type in not having the upper preoculars in contact with the frontal; in this *paucimaculatus* and *lyrophanes*[4] are alike and differ from *biscutatus*.

Subsequent to the completion of this paper one of those last-minute acquisitions was made which so frequently upset what hitherto has seemed a consistent and logical arrangement. This is a specimen sent me alive through the courtesy of Mr. Lee Arnold of the University of Arizona. It was collected at Kingsley, about 37 miles south of Tucson, Pima County, Arizona. This snake differs from the other Arizona material in a number of ways; it is darker in color, more slender in body, has a narrower head, a more prominent vertebral ridge, has no scales between the postgenials (occasional in *lyrophanes*), and the upper preoculars contact the frontal on both sides. In dorsals, ventrals, subcaudals, and the other more important elements of lepidosis, it falls well within the range of *lyrophanes*. The body blotches and tail spots (23–10) are low, but not outside the range of *lyrophanes*. However, it is in the character of the hemipenes that this specimen shows the greatest novelty, for instead of the distal transverse flounces edged with tiny points which certainly characterize *vandenburghi*, and probably *lyrophanes* as well, the outer third is covered with about 54 relatively large spines, the ridges being absent. I use the word "probably" in referring to *lyrophanes* since I do not have available from that species any good extruded organs, as in the case of *vandenburghi;* and I confess to a certain difficulty in

[4] This contact has been observed in a few *lyrophanes* but is quite unusual.

interpreting the configuration of unextruded or partly extruded material. I have examined three sets from *lyrophanes* (2 Arizona, 1 Sonora) and they appear to be similar to *vandenburghi*, with distal fringes rather than spines, although 3 or 4 spines may be present in one.

I wish to point out that, although this specimen may disclose the presence of two species of *Trimorphodon* in Arizona, it does not tend to differentiate *lambda* from *lyrophanes*, since neither the Sonora nor the Lower California specimens have the characters of this peculiar individual. One may presume from the contact between the upper preoculars with the frontal, that it is allied to *biscutatus*, from which, however, it differs in ventral and subcaudal scale counts; or it may be related to *upsilon*. With respect to the preocular-frontal contact in *lyrophanes* (including the possibly valid subspecies *lambda*) I find no contact in 8 specimens from Arizona, one from California, one from Utah, or in 3 from Sonora. Out of 5 specimens from Nevada, contact is barely made on one side only in two specimens, and the same is true of one out of four specimens from Lower California.

Here I leave the puzzle of the status of this peculiar individual until more material can be acquired. I do not think it will prove a subspecies of *lyrophanes*, since a specimen quite typical of this form is at hand from Tucson, only 37 miles down the Santa Cruz River from Kingsley. The wide difference between the hemipenes of this new Arizona specimen and those of *vandenburghi* and *lyrophanes* suggests that the characters of these organs may aid materially in the solution of some of the problems of the Mexican and Central American species.

In determining the intraspecific trends in *lyrophanes* we are badly handicapped by lack of adequate material, as has already been pointed out in discussing the possible validity of *lambda*. While a total of 41 specimens may seem adequate, the territory occupied by the species is so large and so ecologically variable, that no single region is represented by a series large enough to permit a proper survey of local variations, without which, trends cannot be accurately determined. Hence, I have abandoned any idea of a statistical investigation and will merely point out some of the apparent territorial differences. Adequate material may later serve either to prove or disprove these suggestions.

Lower California specimens seem to have more scale rows, on the average, than the mainland specimens, for there are several specimens with 24 rows from the Cape region and none with 21, while the contrary is true over the rest of the range. In ventrals, as well, the Lower California specimens run high; there are indications that the Nevada and Utah snakes are lowest, those from Sonora (*lambda*) being intermediate. The caudals have already been discussed; here seems to be the weightiest character tending to validate *lambda* as a subspecies. The Lower California specimens are low, Nevada intermediate, Arizona intermediate or high, and Sonora high. In this connection it may also be stated that the tail-length ratio of the Sonora snakes is higher than in those from Lower California. I find no apparent differences in the labials, loreals, or oculars. The body blotches are so variable that little of interest is to be learned; the Arizona specimens seem to average lower than other areas, including Sonora and Lower California. In tail spots, as previously discussed, there is an indication of a

significant average difference between snakes from Sonora on the one hand and Lower California on the other, the former running higher. Here again there is a possible verification of *lambda* as a subspecies worthy of recognition.

In pattern and color there is much variation, some of which may be geographically consistent. The Lower California specimens have longer body blotches and proportionately narrower interspaces than the Sonora and Arizona snakes. Also, the stippling in the interspaces is not nearly so evident in the Lower California specimens as in those from the mainland areas. It is to be remembered that this is a character which becomes more evident with age. Some of the Arizona and Sonora snakes are very heavily punctated, especially on the sides, between the major blotches. Finally, there is the splitting of the lyre marks on the head by a central light line. This is characteristic of the Lower California snakes, but is unusual among the others. In both groups there are individuals in which the split is partial.

Field Notes.—I have been able to secure so few data on the life history of *T. lyrophanes* that such as there are have been presented under *T. vandenburghi.* Doubtless the two species differ little in habits. I think it probable that *lyrophanes* is less essentially a rock-dweller than *vandenburghi,* at least in some of the areas inhabited.

Locality Records.—LOWER CALIFORNIA: Cape San Lucas (type locality), San José del Cabo, Santa Anita, Miraflores, Sierra San Lázaro, Todos Santos, La Paz, Santa Rosalía, San Ignacio.

CALIFORNIA: *Riverside County*—Riverside Mountains (near Colorado River); *San Bernardino County*—Vidal.

NEVADA: *Clark County*—Boulder City, 2 mi. s. of Las Vegas.

UTAH: *Washington County*—Saint George, 12 mi. w. of Springdale, Zion National Park.

ARIZONA: *Yuma County*—Gila Mountains, Summit Telegraph Pass (Gila Mountains), Ligurta; *Maricopa County*—Wickenburg (also 9 mi. se. and 12 mi. s. on Hassayampa River), near Cave Creek; *Pima County*—Tucson Mountains (also "A" Mountain), 4 mi. n. of San Xavier Mission, Escuela, mouth of Sabino Canyon (Santa Catalina Mountains), Agua Caliente Ranch (Tanque Verde Mountains), Tanque Verde Ranch (Tanque Verde Mountains), Rosemont; *Cochise County*—Fort Huachuca, Ramsey Canyon (Huachuca Mountains), Tombstone; *Santa Cruz County*—Fort Buchanan, Cayetano Mountains (near Calabasas), Peña Blanca Spring, Patagonia.

SONORA: Guaymas (type locality of *lambda*), La Posa (near Guaymas), Puerto Libertad.

Trimorphodon vilkinsonii Cope

TEXAS LYRE SNAKE

1885. *Trimorphodon vilkinsonii* Cope, Proc. Am. Philos. Soc., Vol. 23, p. 285. Type specimen: USNM 14,268. Type locality: Chihuahua, Mexico.

1887. *Trimorphodon wilkinsonii* Cope, Bull. U. S. Nat. Mus., No. 32, p. 68.

1896. *Trimorphodon upsilon* (part) Boulenger, Cat. Snakes Brit. Mus., Vol. 3, p. 55.

Diagnosis.—A species of *Trimorphodon* characterized by few and widely separated dorsal blotches, and these not split by the transverse light marks characteristic of *lyrophanes, vandenburghi,* and other species.

Range.—Chihuahua and extreme western Texas; probably southern New Mexico.

Material.—Only three specimens are known at this time, the type from Chihuahua, and two from the vicinity of El Paso, Texas. Certain specimens in the British Museum may belong to this species.

Description.—With only three specimens available, and two of these juveniles, the description must necessarily be incomplete. No attempt will be made to segregate the counts between sexes.

The body is of the usual *Trimorphodon* form, but with the head somewhat less distinct than *lyrophanes*. The longest available specimen measures 728 mm., the shortest 272 mm., the latter being the type.

There are 22 or 23 scale rows at mid-body, 21 or 22 on the neck, and 15 or 16 at the base of the tail. There is one pair of lateral suppressions, wherein the second and third rows are condensed to form a new second; or the third and fourth may coalesce. The rest of the suppressions are mid-dorsal. The ventrals vary from 225 to 231 and the subcaudals, which are divided, from 76 to 79. The anal is divided.

The rostral is wider than high and deeply indented below. The frontal is pentagonal, with the point partly separating the parietals. The supraoculars are small and non-imbricate. The upper preoculars do not contact the frontal. The nasal is divided by a suture through the nostril. The loreals are 2–2 in two specimens and 3–3 in the third. They comprise an anterior loreal higher than wide and a somewhat smaller posterior. If a third loreal be present, it consists of a small subloreal under the posterior. The preoculars are 3–3, the upper largest; the postoculars are also 3–3, the upper and lower larger than the middle. The temporals are 3+4 or 3+5. The supralabials are 9, but one specimen has 10 on the left. The fourth and fifth contact the eye; the fifth and sixth exceed the others in size. The infralabials number 11 to 13; the first pair contact on the mid-ventral line; the fifth or sixth is largest. The first five contact the anterior genials. The mental is small and triangular. The genials are in two pairs, the anterior longer, the posterior separated by small gulars. There are 3 or 4 scales on the mid-ventral line between the posterior ends of the anterior genials and the first ventrals, and 6 or 7 gulars between the last infralabials and the adjacent ventrals.

The head markings on this snake are much less prominent than in *lyrophanes* or *vandenburghi*. The head is blue gray on top, with a single brown spot on the back of the frontal and the anterior halves of the parietals. There are some evidences of punctations on the upper surface of the head, particularly in the sutures between plates. The rostral and supralabials are somewhat lighter than

the top of the head. The infralabials and under side of the jaw have little of the gray ground color and comprise the lightest areas of the snake.

The body pattern consists of a series of dark-brown cross bands on a blue-gray ground color; these bands continue on the tail. In the three specimens available, the body bands number from 17 to 22, and the tail spots from 7 to 10. The bands do not encircle the body, but do engage the outer ends of the ventrals. There is also a series of small secondary blotches, of which there are one or two between each major pair. These usually begin on the first scale row and are carried below to the ends of the ventrals.

The primary blotches are wider dorsally than laterally, and the interior scales may be somewhat lighter than the borders, possibly a last vestige of the characteristic *Trimorphodon* transverse light bars. Between blotches the ground color is stippled with darker gray, except for a lighter edge bounding each primary blotch. The interspaces are much wider than the blotches themselves, even mid-dorsally, where the blotches are widest. Along the median line the blotches are 4 or 5 scales wide (end to end), decreasing to 2 or 2½ scales at the base of the tail. The interspaces are 8 to 12 scales wide.

Relationships.—*Vilkinsonii* differs so considerably from *lyrophanes* in pattern it would seem highly improbable that an intergrading series should be found in southeastern Arizona and southwestern New Mexico. Its nearest existing relative may be *upsilon* to the south.

Locality Records.—CHIHUAHUA [city?] (type locality).

TEXAS: *El Paso County*—5 mi. n. of El Paso (e. slope Mt. Franklin), Rio Grande River (3 mi. nw. of El Paso).

KEY TO THE LYRE SNAKES

OF THE GENUS TRIMORPHODON IN THE UNITED STATES

A. Body blotches (exclusive of tail) usually less than 23; width of blotches (along the body) much less than interspaces ..... *T. vilkinsonii*
Extreme western Texas, northern Chihuahua, and probably southern New Mexico.

AA. Body blotches usually exceed 22; width of blotches (along the body and neglecting the light lines transversely splitting each blotch) equal to, or greater than, interspaces

B. Anal plate normally entire ..... *T. vandenburghi*
Southern California from Los Angeles County and central Inyo County south into northern Lower California.

BB. Anal plate normally divided ..... *T. lyrophanes*
Southern and central Lower California, Sonora,

southern, west-central and northwestern Arizona, southwestern Utah, southern Nevada, and southeastern California along the Colorado River.

ACKNOWLEDGMENTS

I wish to express my thanks to the following institutions and individuals for the loan of material: United States National Museum, California Academy of Sciences, Museum of Vertebrate Zoology, Los Angeles Museum, Boulder Dam Recreational Area, University of California at Los Angeles, Chicago Academy of Sciences, Stanford University, American Museum of Natural History, Dr. E. H. Taylor, Messrs. Harold Woodall, James Deuel, and Charles E. Shaw. Information on particular specimens was furnished by Dr. Doris M. Cochran, Mrs. Helen T. Gaige, Dr. R. B. Cowles, Mr. C. M. Bogert, Dr. E. H. Taylor, and Mr. R. K. Grater. I am indebted to Messrs. Lawrence H. Cook, James Deuel, and Charles E. Shaw for assistance in making scale counts; and to Mrs. Elizabeth Leslie for statistical computations. C. B. Perkins was kind enough to review the paper and made several valuable suggestions.

BIBLIOGRAPHY

Boulenger, G. A.

1896. Catalogue of the Snakes in the British Museum (Natural History). Vol. 3, pp. 1–727, plts. 1–25.

Campbell, Berry

1934. Report on a Collection of Reptiles and Amphibians Made in Arizona During the Summer of 1933. Occ. Papers Mus. of Zoöl., Univ. of Mich., No. 289, pp. 1–10.

Cope, E. D.

1860. Notes and Descriptions of New and Little Known Species of American Reptiles. Proc. Acad. Nat. Sci. Phila., Vol. 12, pp. 339–345.

1861. Contributions to the Ophiology of Lower California, Mexico and Central America. Proc. Acad. Nat. Sci. Phila., Vol. 13, pp. 292–306.

1886. Thirteenth Contribution to the Herpetology of Tropical America. Proc. Am. Philos. Soc., Vol. 23, pp. 271–287.

1887. Catalogue of Batrachians and Reptiles of Central America and Mexico. Bull. U. S. Nat. Mus., No. 32, pp. 1–98.

1892. A Critical Review of the Characters and Variations of the Snakes of North America. Proc. U. S. Nat. Mus., Vol. 14, pp. 589–694.

1900. The Crocodilians, Lizards, and Snakes of North America. Rept. U. S. Nat. Mus. for 1898, pp. 153–1270, pts. 1–36.

Cowles, R. B., and Bogert, C. M.

1935. Observations on the California Lyre Snake, *Trimorphodon vandenburghi* Klauber, with Notes on the Effectiveness of its Venom. Copeia, No. 2 of 1935, pp. 80–85, figs. 1–3.

Duges, A.

1884. Nota sobre el Colcoatl ó *Trimorphodon* (*Dipsas*) *biscutata*, D. B.

La Naturaleza, Vol. 6, pp. 145–148.

KLAUBER, L. M.

1924. Notes on the Distribution of Snakes in San Diego County, California. Bull. Zoöl. Soc. San Diego, No. 1, pp. 1–23, figs. 1–5.

1928. The *Trimorphodon* (Lyre Snake) of California, with Notes on the Species of the Adjacent Areas. Trans. San Diego Soc. Nat. Hist., Vol. 5, No. 11, pp. 183–194, plts. 22–23.

1931. A Statistical Study of the Snakes of the Southern Border of California. Bull. Zoöl. Soc. San Diego, No. 8, pp. 1–93, figs. 1–8.

1939. Studies of Reptile Life in the Arid Southwest. Bull. Zoöl. Soc. San Diego, No. 14, pp. 1–100.

RIDGWAY, ROBT.

1912. Color Standards and Color Nomenclature. Pp. IV+43, plts. 1–53.

RODMAN, GAGE B., JR.

1939. Habits of *Trimorphodon vandenburghi* in Captivity. Copeia No. 1 of 1939, p. 50.

SLEVIN, J. R.

1931. Range Extensions of Certain Western Species of Reptiles and Amphibians. Copeia No. 3 of 1931, pp. 140–141.

STEJNEGER, L.

1895. The Poisonous Snakes of North America. Rept. U. S. Nat. Mus. for 1893, pp. 337–487, plts. 1–19, figs. 1–70.

TAYLOR, E. H.

1937a. Notes on the Herpetological Fauna of the Mexican State of Sonora. Univ. Kans. Sci. Bull., Vol. 24, No. 19, pp. 475–503, plt. 43.

1937b. Notes on the Herpetological Fauna of the Mexican State of Sinaloa. Univ. Kans. Sci. Bull., Vol. 24, No. 19, pp. 505–537, plts. 44–46.

1939. On Mexican Snakes of the Genera *Trimorphodon* and *Hypsiglena*. Univ. Kans. Sci. Bull., Vol. 25, No. 16, pp. 357–383, plts. 35–38.

VAN DENBURGH, JOHN

1922. The Reptiles of Western North America. Occas. Papers Calif. Acad. Sci., No. 10; Vol. 1, Lizards; Vol. 2, Snakes and Turtles; pp. 1–1028, plts. 1–128.

VAN DENBURGH, JOHN, and SLEVIN, JOSEPH R.

1921. A List of the Amphibians and Reptiles of the Peninsula of Lower California, with Notes on the Species in the Collection of the Academy. Proc. Calif. Acad. Sci., Ser. 4, Vol. 11, No. 4, pp. 49–72.

SUMMARY

The lyre snakes of the genus *Trimorphodon* are represented in the United States by three species: *T. vandenburghi*, *T. lyrophanes*, and *T. vilkinsonii*. *T. lambda* is for the present considered a synonym of *lyrophanes*, but, with additional material, may eventually deserve recognition as a valid subspecies.

PLATE 7

Fig. 1. *Trimorphodon vandenburghi.* Type specimen. Collected at Wildwood Ranch, San Diego County, California.

Fig. 2. *Trimorphodon lyrophanes.* Collected at Cape San Lucas, Lower California, Mexico.

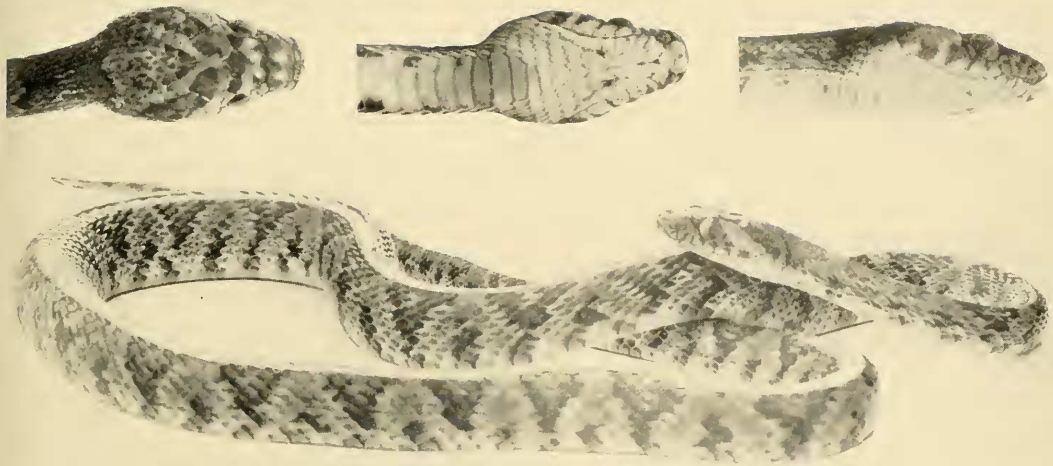


Fig. 1.

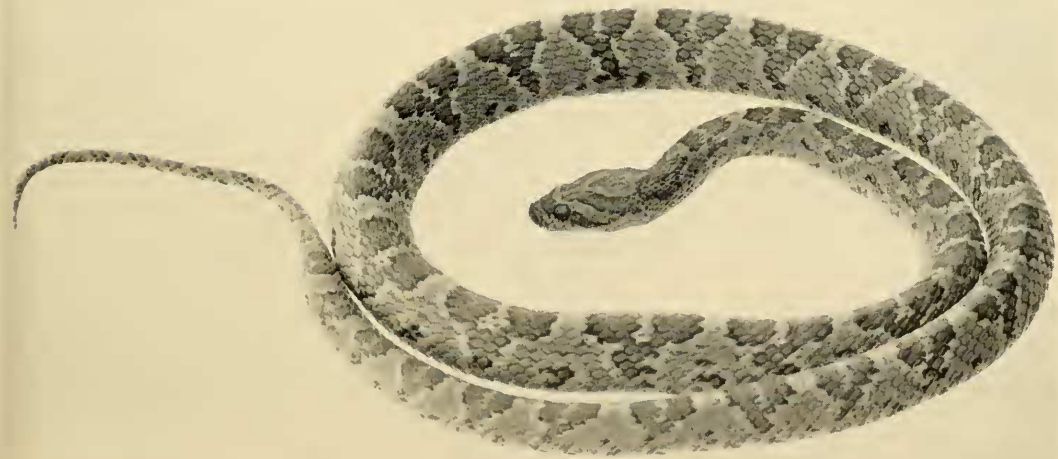


Fig. 2.